Voice interactive classroom, a service-oriented software architecture for speech-enabled learning

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ABSTRACT

Software technology is creating a ubiquitous context for human living and learning in which new modes of interaction are gradually being incorporated. Speech-enabled software brings a new way of interacting with the Internet, but auditory access to web resources needs to be more broadly supported by software architectures. This paper introduces "Voice Interactive Classroom", a software solution that proposes a middleware approach to provide cross-platform multi-channel access to internet-based learning.

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1. Introduction

Internet-based learning has complemented and in some instances even replaced traditional classroom teaching and learning over the past two decades (Masie, 2002) (Zhang et al., 2004). Learning management systems (LMSs) have evolved during this period in an attempt to keep pace with the World Wide Web (WWW), incorporating new technologies as well as adding pedagogical principles to a wide variety of software tools.

It is vital to the learning process that the information in the e-learning systems be organised according to the needs of each individual student (Paule et al., 2008). Until now, only Adaptive Educational Hypermedia (Brusilovsky, 2001a) caters to the needs of each individual student and adapts to his/her goals (Cliford, 2000), knowledge level (De Bra and Calvi, 1998), background, interest, preferences (Brusilovsky, 1996), stereotypes (Zakaria and Brailsford, 2002), cognitive preferences (Chen and Macredie, 2002) and learning styles (Stash et al., 2004). Learning styles, the different ways in which a person can learn, are related to an understanding of learning as an active process. Psychologists have proposed several complementary taxonomies of learning styles (Alonso et al., 2002) (Dunn and Dunn, 1978) (Sarasin, 1998) (Felder and Silverman, 1988) (Kolb, 1984). We select the Felder–Silverman taxonomy, which includes three dimensions: Input (visual/verbal), organisation (inductive/deductive), and understanding (sequential/global). In the visual/verbal learning style dimension, we can clearly see the distinction between a visual learner who learns and remembers best which is seen – pictures, diagrams, flow charts, time lines, films and demonstrations – and a verbal learner who learns best from audio explanations. Therefore, if an LMS offers two types of interactions, both visual and verbal, it provides students the possibility to adopt a learning style that is most suitable for their needs.

At the same time, an interaction with internet-based learning systems has evolved from using the traditional access from a personal computer's web browser to more flexible access from mobile devices, which has stimulated research in ubiquitous learning (u-learning) and mobile learning (m-learning). However, in both cases, e-learning systems have created a context in which the interaction with the user is carried out mainly by using visual perception. The use of visual-only interaction implies that there are only a limited number of situations in which students can make use of a learning management system.

Students' personal needs and learning contexts, along with advances in human-machine interaction and pervasive technologies, constantly force learning management systems to adapt to different situations and create new educational scenarios. Thus, an evolution is required in the design of the architectural structures of e-learning platforms, which can then develop into ubiquitous and mobile e-learning systems.

This paper is organised as follows. In Section 2, below, we provide the motivation for this work. The following section provides a background on web-based e-learning platforms, e-learning frameworks and audio interfaces for Internet-based applications. We then proceed to describe "Voice Interactive Classroom", a software solution that automates the use of voice in learning management systems. Finally, we present the conclusions of this work and suggest directions for further research.

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2. Motivation

e-learning and the enabling learning technologies are concerned with making learning experiences in all types of settings more effective, efficient, attractive and accessible for learners (Koper and van Es, 2004). Ubiquitous computing is a domain that aims to enhance computer use by making many computers available throughout the physical environment (Weiser, 1993); however, current e-learning platforms are not yet ready to take full advantage of pervasive computing scenarios.

We have focused this study on the flexibility provided by visual and auditory interfaces in the adaptation of learning management systems to ubiquitous and mobile learning. In particular, the following five scenarios make it either necessary or highly recommended to complement visual learning with audio interfaces:

- Learning processes in which sound is the main source of information, as in the case of music and language learning (Patel, 2008).
- Students with perceptual auditory learning styles or those who prefer to learn by using both their visual and auditory senses (Barbe and Milone, 1981).
- Hands-busy, eyes-busy and mobility-required situations, e.g., in routine physical activities like walking and driving (Shneiderman, 2000).
- The device has speech input/output capabilities but only a small screen (Niklfeld et al., 2001).
- A disability does not allow a person to make use of a visual display or input/output devices, for instance when users have visual or motor impairments (Cohen and Oviatt, 1995).

The Universal Design for Learning (UDL)(Rose and Meyer, 2002) reflects an awareness of the unique nature of each learner and the need to accommodate differences, creating learning experiences that suit the learner and maximise his or her ability to progress (Center for Applied Special Technology; http://www.cast.org/). Moreover, in the particular case of higher education, The Universal Declaration of Human Rights (1948) (http://www.un.org/en/documents/udhr/) states the right to education and equal access to higher education for all on the basis of merit (Art 26).

In order to enhance current learning management systems, provide ubiquitous and mobile access to learning resources and adapt the learning process to best suit each individual student needs, we believe that e-learning needs to adapt to the aforementioned scenarios by complementing visual interfaces with other means of communication, such as audio interactions.

3. Background

3.1. web-based e-learning platforms

Web-based e-learning platforms have been developed since the 1990s. The term includes Course Management Systems (CMSs), Learning Management Systems (LMSs), Learning Content Management Systems (LCMSs), Virtual Learning Environments (VLEs) and, more generally, any software structure designed to give support to on-line learning. Although historically the most common use has been course management, current e-learning platforms often include a wide variety of integrated on-line tools including applications for learning management, publishing educational material as well as collaborative and communication functionality.

The University of Oviedo is one of the pioneers in Spain in complementing classroom teaching with on-line education (blended learning). Between 1997 and 1999, the University worked on two self-developed learning solutions, the Welcoming Environment for Lifelong Learning in Pathology (Sampedro et al., 1998) and a more general virtual classroom initially called Aulanet (Pérez et al., (1999)), along with other e-learning solutions such as the III Virtual Spanish American Congress of Pathological Anatomy (Martínez et al., 1999). At a later stage, "Web-based Course Tool systems" (WebCT; http://www.blackboard.com/), one of the first web-based learning environments, commonly situated at the top of the list of most recommended/used learning packages, was the choice for the University's virtual classroom.

In October 2006, three years after the first release of Moodle (http://moodle.org/), a free open source software package originally developed by Martin Dougiamas at the University of Curtin (Australia), the University of Oviedo decided to migrate its virtual classroom from WebCT to Moodle. This migration has also been performed by many public universities in Spain and other universities and organisations all around the world (Ahmed, 2005; Corich, 2005; Jamieson and Verhaart, 2005).

At the time this paper was written (October 2009), Moodle and WebCT were the most commonly used learning management systems in Spanish public universities (Fig. 1).
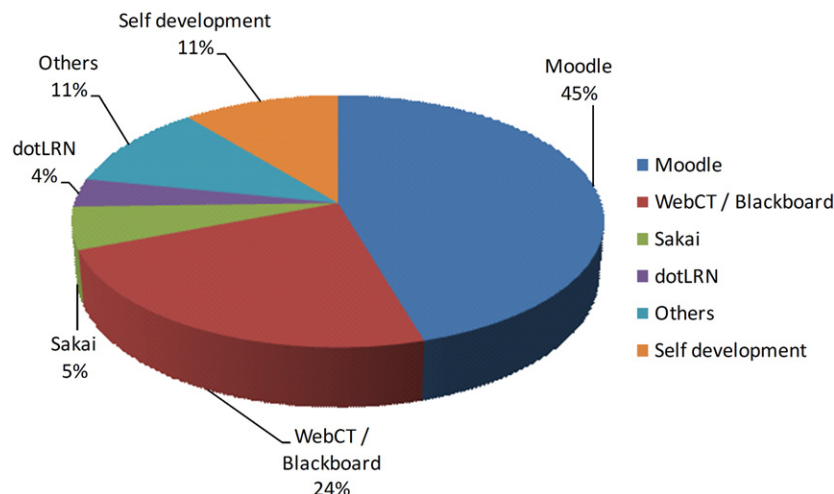

Fig. 1. Use of web-based learning platforms at Spanish public universities (data collected from the universities).